AD-A265 495

ITATION PAGE

Form Approved
OMB No. 0704-0188

ted to average 1 hour per response, including the time for reviewing instructions, searching existing data sources viewing the collection of information. Send comments regarding this burden estimate or any other aspect of this urden to Washington Headquarters Services, Directorate for nformation Operations and Reports, 1215 Jefferson)ffice of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	1992	THESIS/DISSERTATION

4. TITLE AND SUBTITLE
The Effects ofEvaluation and Production Blocking on the Performance of Brainstorming Groups

5. FUNDING NUMBERS

6. AUTHOR(S)
Kevin D. Osten, Captain

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
AFIT Student Attending: Purdue University

8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT/CI/CIA-92-134

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
AFIT/CI
Wright-Patterson AFB OH 45433-6583

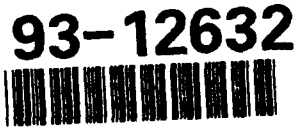
10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for Public Release IAW 190-1
Distribution Unlimited
ERNEST A. HAYGOOD, Captain, USAF
Executive officer

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*



14. SUBJECT TERMS	15. NUMBER OF PAGES
	70
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT

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Osten, Kevin, D., Captain, USAF, M.S., Purdue University, 1992. The Effects of Evaluation and Production Blocking on the Performance of Brainstorming Groups, 70 pages.

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THE EFFECTS OF EVALUATION AND PRODUCTION BLOCKING ON THE PERFORMANCE OF BRAINSTORMING GROUPS

A Thesis

Submitted to the Faculty

of

Purdue University

by

Kevin D. Osten

In Partial Fulfillment of the

Requirements for the Degree

of

Master of Science

August 1992

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INTRODUCTION

All throughout society people gather together for one purpose or another. In some instances these gatherings are considered groups, but in other instances these gatherings are just that, gatherings. Why are some aggregates of people considered an audience, a mob, or a crowd, but not a group? Consider the following examples; people living in the same residence hall, a room full of students taking a class, all the males attending Purdue University, or people standing on a street corner waiting for the walk signal. The people in the above examples share many things in common such as living quarters, quest for knowledge, gender, or desire to cross the street, but they are missing a critical element of what makes an aggregate of people a group.

Now consider these examples; a jury, a team of automobile assemblyworkers, an athletic team, or members of a special interest group. Once again, the people in the above examples share many things in common such as a sense of civil duty, an employer, a love for a particular sport, or an interest in a particular topic. The people in the above examples, however, are considered groups because they share the essential feature of a group, the feeling of interdependence.

McGrath (1984) provides a representative definition of a group by stating that a group is "an aggregation of two or more people who are to some degree in dynamic interrelation with one another" (McGrath, 1984, p.8). The emphasis of the above and other definitions of a group is the concept of dynamic interaction or interdependence which leads to feelings of groupiness through mutual awareness, interaction, and the formation of a history. Without interdependence a gathering of people share no common group bond, have no future together as a group, and fail to interact on an ongoing basis. When thinking of a group it is important to understand that there is not a single definition that takes into account all the different types of groups. It is vital that group members at least know who is and is not in their group, and have some type of interdependence with those people who are members of their group. After one understands the definition of a group it is important to know what types of groups exist.

McGrath has identified three types of groups, the natural group, the concocted group, and the quasi-group (McGrath, 1984). A natural group is a group such as a family or work group "that exists independent of the researcher's activities or purposes" (McGrath, 1984, p.41). A concocted group can be a natural or an ad hoc group that the researcher assembled for the specific purpose of studying some characteristic of that group. A quasi-group is a group that was assembled for the specific purpose of research and performs under highly

constrained and/or artificial patterns of activity.

Within each of the above typologies there are several subgroups that are characterized by the type of interaction and tasks that each subgroup performs. Although natural groups are the most prevalent group in society, the group of interest for this thesis is the quasi-group. In addition to being used for many experimental purposes, the quasi-group has been used extensively for the purpose of furthering our understanding of the group processes that occur when the brainstorming technique is used by groups for idea generation.

The intent of this thesis is to examine and discuss the brainstorming literature and demonstrate a need for additional research of the brainstorming process. The thesis will begin with a short background on brainstorming as it was taught by Osborn and will look at a few of the early empirical tests of brainstorming. The reader will then be introduced to some of the processes that are characteristic of groups while brainstorming. Two of the processes, evaluation apprehension and production blocking, will be looked at in detail and discussed in conjunction with the relevant empirical findings on brainstorming. The hypotheses will be introduced and the procedures of the experiment will be presented in the methods section. The findings will be shown in the results section and will be addressed further in the discussion section. The thesis will conclude by addressing some of this study's limitations and provide suggestions for future research.

Brainstorming

The brainstorming technique was introduced by Osborn (1953) as a means of idea generation for groups. Groups employing the brainstorming technique would sit around the table and express solutions to a particular problem. Brainstorming was different from ordinary problem-solving sessions because of the creation of rules that the groups were required to follow which ensured that their brainstorming would be maximally effective. The four rules of brainstorming are: 1) generate as many ideas as possible 2) the wilder the generated ideas the better, 3) improve or combine on the ideas of others, and 4) do not be critical of the ideas of others.

With the use of brainstorming, Osborn (1953) contended that groups would outperform individuals two to one for idea quantity and quality. Osborn reasoned that performance would be enhanced in brainstorming groups because individuals would be freed from self criticism and the criticism of others if the rules of brainstorming were followed. Additionally, any novel ideas suggested by one group member could possibly lead to more novel or original ideas by other group members.

In its heyday brainstorming was successfully used throughout the military, Government, industry, and in education, with several claims about its effectiveness. Upon closer examination researchers found that the support for the effectiveness of brainstorming was exaggerated, partisan, and rarely documented, and that additional information would need

to be gathered to assess the true merits of the brainstorming technique (Jablin & Seibold, 1978).

Taylor, Berry, and Block (1958) were the first to study Osborn's brainstorming technique in the laboratory and were interested in determining if group participation, using brainstorming, facilitated or inhibited creative thinking. Total number of ideas, feasibility, generality, effectiveness, probability, and significance were the dependent measures of the Taylor, Berry, and Block experiment. Results showed that nominal groups (those groups composed of four subjects working independently) outperformed real groups of four subjects for total number of ideas, but that there was no difference between real and nominal groups on the other dependent measures when the difference between total number of ideas was taken into account. Results from the Taylor, Berry, and Block study did not support Osborn's claim and indicated that nominal group performance was almost twice as good as the performance of real groups. Taylor, Berry, and Block concluded that group participation when using brainstorming inhibits creative thinking. Several additional studies testing Osborn's brainstorming claim have been done (Bouchard & Hare, 1970; Jablin, 1981; Street, 1984), with the majority of them not supporting Osborn's claim.

Sorting through the brainstorming literature reveals that groups generate more ideas than individuals on brainstorming tasks when group results are compared to the outputs of one

individual. However, when real group outputs are compared to outputs that combine the non-overlapping responses of the same number of individuals performing alone (nominal group), the nominal groups consistently outperform the real groups (Diehl & Stroebe, 1987; Gurman, 1968; Maginn & Harris, 1980). In a review of the brainstorming literature Diehl and Stroebe found that 18 of 22 experiments reported that nominal groups generated more ideas than real groups. The group size in the experiments that did not support Osborn's claim ranged from three to nine members with four being average. In the three studies that supported Osborn's claim the groups were composed of only two members (these real groups matched but did not exceed the performance of the nominal groups). With the above findings in mind, it can be safely concluded that nominal groups outperform real groups for idea generation during brainstorming tasks.

Although not as conclusive as quantity, quality has also been a frequent dependent measure in brainstorming research. In their meta analysis Diehl and Stroebe (1987) found that nominal groups outperformed real groups for total quality in all instances. When total number of ideas was accounted for, as in average quality, Diehl and Stroebe found no difference between real and nominal groups for quality of ideas. In their meta analysis, Lamm and Trommsdorf (1973) found performance differences, in terms of average quality, to be related to the type of group or the brainstorming topic used.

Overall, it appears that nominal groups outperform real groups on quality only because they produce more ideas overall. When quantity is accounted for the results are mixed and depend upon group and topic variables. Since quality is seldomly reported, additional research is necessary to determine if quality is indeed different between real and nominal groups.

Group Processes

Why brainstorming performance is different between real and nominal groups is best understood by looking at some of the group processes that are characteristic of the group setting and absent when an individual performs alone, as in a nominal group. In their 1973 article, Lamm and Trommsdorf discuss several group process variables that are characteristic of face to face groups performing brainstorming tasks. Each of the processes may affect a group in a myriad of ways, but this discussion will be limited to how these processes improve the performance of a group through social facilitation and how these processes debilitate group performance through process losses. The discussion will begin with the processes that relate to social facilitation followed by the processes that relate to process loss in group performance.

Social Facilitation. Social facilitation is an improvement in the performance of individuals while in the presence of other people (Zajonc, 1965). The 'other' people

can be observers, group members, or, depending on the theory one adheres to, nonattentive bystanders. It is only important to understand that other people must be present for social facilitation to occur. Several theories have been generated for explaining why people respond differently in the presence of others, a phenomenon Zajonc refers to as compresence. In group settings, social facilitation can be explained by using the processes of arousal, evaluation apprehension, distraction, and cognitive stimulation. The discussion will now focus on how each of these processes leads to social facilitation.

Zajonc (1965) claims that the mere presence of other people results in the arousal of an individual leading to increased effort. On tasks that require a dominant response increased effort leads to performance enhancement and on tasks that require a nondominant response increased effort leads to performance impairment. In a test of the dominant response hypothesis Zajonc and Sales (1966) conducted a pseudorecognition experiment in which subjects were exposed to several nonsense words at differing frequencies. They found that when an audience was present subjects guessed the word they were exposed to most frequently, indicating a dominant response. When no audience was present, however, the subjects guessed a larger variety of words indicating a nondominant response. Support for this mere presence interpretation has also been provided by Berger (1981), Towler (1986), and

Worringham and Messick (1983).

Cottrell (1972) disagreed with Zajonc about the mere presence effect and contends that the presence of others increases arousal only if the observers operate in an evaluative capacity. For his interpretation Cottrell claims that the presence of other people arouses the performer because they have learned from previous experience that observation often covaries with the distribution of rewards and/or punishments. When an individual is present the individual performing the task becomes apprehensive about their performance because they do not know if a reward or a punishment will be delivered. The uncertainty of the outcome raises the individuals' drive level and results in facilitation if the task requires a dominant response or impairment if the task, such as brainstorming, requires a nondominant response. This process is referred to as evaluation apprehension.

Cottrell (1972) tested his hypothesis using a pseudorecognition task similar to the one conducted by Zajonc and Sales (1966). Cottrell's experiment differed from Zajonc and Sales in that he had two observer conditions, audience and mere presence and an alone condition. Results of this experiment showed no differences in word recognition preference between the alone and mere presence subjects. In the audience condition, however, subjects recognized those words they were most familiar with, indicating a dominant

response. These results indicate that the presence of an audience only leads to the facilitation of a dominant response when the audience operates in an evaluative capacity. Other researchers support Cottrell's theory and have found that an evaluative audience is necessary for social facilitation to occur (Henchy & Glass (1968); Martens & Landers (1972). Regardless of which of the above interpretations one relies on, the presence of other people leads to changes in effort expended on the task through increased arousal of the performer.

The distraction that occurs when others are present is another way of explaining how the presence of other people results in social facilitation. Proponents of distraction-conflict theory claim that the presence of other people distracts the performer away from the task so they must increase the amount of effort they expend on the task to maintain their previous level of performance (Baron, 1986; Sanders, Baron, & Moore, 1978). If the amount of effort exceeds the distraction they experience then their performance improves, but if the distraction exceeds the increased effort performance impairment occurs.

The presence of other people not only distracts people from the task, but can also provide an impetus for ideas that are attributable to the content of those other people's speech. This process is referred to as cognitive stimulation (Lamm & Trommsdorf, 1973). In group situations cognitive

stimulation occurs because the expressed idea of one person serves as a stimulus or building block for an idea of another member. Without the other person's idea the new idea would not have been generated. Cognitive stimulation is also referred to as hitchhiking in the brainstorming literature.

Group performance can be improved in many ways, such as through factors within the organizational context and from the design of the group itself (Hackman, 1987), but for ad hoc groups, such as those used in brainstorming experiments, social facilitation is the primary reason for performance enhancement. Social facilitation has been demonstrated as a benefit of group processes, but working in a group can also lead to process losses that lead to performance impairment of the group. The discussion will now turn to some of the process losses that Lamm and Trommsdorf (1973) identified in their review of group processes.

Process Losses. Process losses are those processes that occur within a group which result in reduced performance of that group. Cognitive interference, evaluation apprehension, production blocking, and social loafing are the process losses that will be discussed, beginning with cognitive interference.

Cognitive interference is a form of process loss that occurs when the content of the speech of another group member interferes with the internal processing of information of other group members (Lamm & Trommsdorf, 1973). Cognitive interference occurs in brainstorming groups because as ideas

are expressed they may interfere with the idea generating ability of other group members.

Evaluation apprehension, although mentioned above as a form of social facilitation, can also be considered as a form of process loss. In the process loss arena evaluation apprehension occurs when group members become apprehensive about submitting ideas to the group because they feel that other group members will evaluate and/or criticize those ideas. The result of evaluation apprehension is that group members withhold any ideas that they feel are unsafe because they don't want them to be unduly evaluated or criticized (Lamm & Trommsdorf, 1973).

Production blocking is a form of process loss that is based on the norm that group members will not talk while another individual is talking (Lamm & Trommsdorf, 1973). In brainstorming groups that follow this norm the process of idea generation is stifled because only one person can express their ideas to the group at a time and the other members must wait their turn.

A final type of process loss is that referred to as social loafing (Latane', Williams, & Harkins, 1979). Social loafing leads to reduced group performance because members rely on the efforts of other group members and reduce the effort they put forth. The overall result is reduced performance on tasks that require the additive efforts of all group members. Social loafing is more pronounced when

individual inputs are difficult to identify (Williams, Harkins, & Latane', 1981).

The processes dealing with social facilitation and process loss discussed above are not present in every group situation, but, when present, vary in strength and effect upon group and individual performance. It is safe to conclude that in every group situation some of these group process variables are present, and they must be considered when addressing issues such as group performance. The proposal will now look at some of the explanations that have been developed to decipher the performance difference between real and nominal brainstorming groups.

Explanations for Performance Differences

Several explanations have been presented that attempt to explain the performance difference, in number of ideas generated, between real and nominal groups. Street (1974) proposed that evaluation apprehension exists or that groups establish norms for low or no performance resulting in inferior group performance. Kerr and Brunn (1983), and Petty, Harkins, and Williams (1980) propose that social loafing is responsible for the inferior performance of real groups. Maginn and Harris (1980) suggest that groups pursue a limited train of thought, suffer from social facilitation of dominant responses, or that production blocking occurs. Diehl and Stroebe (1987) propose production blocking, social loafing, and/or evaluation apprehension. Collaros and Anderson (1969)

propose evaluation apprehension and Lamm and Trommsdorf (1973) suggest production blocking as reasons for the inferior performance of real groups. Not all of the above explanations have received empirical support, but evaluation apprehension and production blocking have been identified as major influences in the inferior performance of real groups compared to nominal groups (Diehl & Stroebe, 1987; Lamm & Trommsdorf, 1973). These two factors will be the focus of the next sections.

Evaluation Apprehension. Evaluation apprehension has been studied by looking at evaluation from sources within a group (Collaros & Anderson, 1969; Street, 1974), and from sources outside a group or individual (Diehl & Stroebe, 1987; Maginn & Harris, 1980), with the conclusion that high levels of evaluation reduce the number of ideas generated. To better understand how the group setting causes evaluation apprehension, Street (1974), conducted an experiment to test his hypotheses that it was the evaluation that occurred within the group that was responsible for the reduced productivity of groups, not just the presence of other people. Street's experiment had subjects brainstorm alone, in the presence of others (coaction), or in a group (interaction). Findings of his experiment indicated that the number of ideas generated was similar between individuals working alone or in the coaction condition and that number of ideas generated by the

interacting subjects was significantly less than subjects in either of the other conditions. The above findings show that it is not the mere presence of others that results in evaluation apprehension and lower performance, but it is the presence of others who can serve as evaluators that results in evaluation apprehension and lower performance of interacting groups working on brainstorming tasks.

The composition of the group may have a moderating effect on the evaluation apprehension that members experience and was the subject of an experiment conducted by Collaros and Anderson (1969). In their experiment, Collaros and Anderson manipulated the expertise of members within a group to examine the inhibitory effects that perceived expertise of group members had on less experienced members. Subjects in this experiment were informed that no one in their group had brainstorming experience, that one other person had brainstorming experience, or that all the other members had brainstorming experience. Results of this study showed that the evaluation apprehension of individuals increased as the number of members with experience increased. Additionally, subjects feeling the most apprehension produced the fewest ideas during the brainstorming trial. The results of Street's (1974) and Collaros and Anderson's experiments support the notion that evaluation apprehension can occur from sources within the group, but, as was mentioned above, evaluation from sources outside the group may also cause apprehension among

group members. We will now look at three experiments that were conducted to determine how evaluation from sources outside the group affected group and individual performance.

Maginn and Harris (1980) conducted an experiment to determine the inhibitory effect that immediate or delayed and relevant or irrelevant evaluation had on individual brainstorming performance. Subjects were told that their ideas would be evaluated for quality and quantity by judges sitting behind a one-way mirror (immediate) or by judges sometime during the next week (delayed). The responses of individuals performing alone were compared against the performance of nominal and real control groups. The results of this experiment showed that evaluation from outside sources had no significant inhibitory effect on individual brainstorming performance. In their discussion Maginn and Harris admit that their evaluation manipulation may not have contained all the components necessary to create evaluation apprehension in subjects. Although a manipulation check was conducted, it was only to ascertain the subjects' understanding of the manipulation instructions and not for how evaluated they felt. Without the correct manipulation check it is difficult to determine how evaluated the subjects felt.

In response to the results of Maginn and Harris (1980), Diehl and Stroebe (1987) conducted several experiments to test their hypotheses about evaluation apprehension and group performance. In their second experiment they used procedures

of evaluation apprehension similar to those of Maginn and Harris and, in contrast, found that high levels of evaluation resulted in reduced individual performance. To determine if evaluation apprehension would also reduce the performance of a group Diehl and Stroebe conducted a third experiment involving brainstorming groups.

In their third experiment high evaluation was manipulated by informing the subjects that 1) their performance would be videotaped and used for demonstration purposes in another class, or 2) that judges were sitting on the other side of the one-way mirror and would be evaluating their ideas on quality and originality (Diehl & Stroebe, 1987). Low evaluation was manipulated by removing the one-way mirror and video camera and by telling the subjects nothing else. Results showed that significantly more ideas were produced when subjects worked under low levels of evaluation compared to those subjects who worked under high levels of evaluation, indicating an inhibitory affect from evaluators from outside the group.

In reviewing the role of evaluation on group performance, it is quite clear that evaluation from within the group creates a reduction in group performance (Collaros & Anderson, 1969; Street, 1974). Although the results of experiments involving evaluation from sources outside the group are at the present time inconclusive, the threat of any type of evaluation should generate feelings of apprehension within

groups and reduce their performance on a brainstorming task. The first hypothesis is as follows.

Hypothesis 1. Groups performing under high levels of evaluation, from sources outside the group, will produce fewer ideas than groups performing under low levels of evaluation from sources outside the group.

Production Blocking. Reduced group and individual performance is not limited to the effects of evaluation apprehension. Production blocking has also been identified as a major threat to the idea generating performance of groups (Lamm & Trommsdorf, 1973). The exact process for how production blocking reduces group performance has not been identified, mostly due to lack of empirical inquiry, but several explanations have been generated. Lamm and Trommsdorf claim that production blocking occurs because individuals working in a group are required to share all of the available interaction time with the other members of the group. The result is that each member gets only a fraction of the time they would have if they were working alone. Other researchers, however, claim that time sharing is not a probable cause for process loss because ideas taper off towards the end of the brainstorming session, leaving ample time for interaction. Diehl and Stroebe (1987) propose that while group members are waiting their turn they may forget

their idea, become distracted while listening to others, or are unable to generate new ideas while holding their current idea in short term memory. To test their production blocking hypothesis, Diehl and Stroebe conducted their fourth experiment.

The fourth experiment (Diehl & Stroebe, 1987) was designed to examine the production blocking process occurring in groups by using an elaborate system of colored lights that indicated who was talking at any given time. Blocking was manipulated by informing the subjects that they could only talk when no lights were lit (if lights were lit other subjects would be talking, thus simulating production blocking), or that they were to disregard the lights and talk at will. Communication was manipulated by the presence or absence of earphones that allowed subjects to hear the brainstorming of the group.

The results of experiment four indicated that production blocking had a significant negative effect on idea generation. More ideas were produced when subjects could immediately present their ideas as they occurred, compared to waiting their turn. Compared with the findings of the other experiments conducted by Diehl and Stroebe (1987), production blocking was the most strongly supported explanation for reduced group performance. A shortcoming of experiment 4, however, was the absence of the group environment. Since subjects did not ever see each other and could only hear the

communication of others in the communication condition, the application of these results to a real group situation seem limited.

An alternative method for manipulating production blocking in group situations was provided in a follow-up trial during Street's 1974 experiment. During the original experiment a group member volunteered to record the responses of the group, but during the follow-up trial each member was allowed to write down their own responses. Comparing the results of the follow-up study to the original experiment showed a slight but nonsignificant performance improvement.

A potential benefit of allowing group members to brainstorm and record their own ideas as Street did in 1974 is that a better understanding of the underlying processes of production blocking may be developed. Specifically, the interpretations that members forget their ideas, or that group members cannot generate additional ideas while remembering an idea they haven't presented can be tested. There is merit to Street's method of reducing production blocking, but the method needs additional refinement.

The experimental results concerning production blocking presented above indicate that production blocking is detrimental to group performance. Unfortunately, a study has not yet been done that incorporates a production blocking manipulation into an actual group setting. Although Street did employ this manipulation on a few groups during a follow-

up study, a confound was introduced through his manipulation. By allowing all members of the group to record their own ideas the group size was actually increased to three producing members, whereas during the experiment, one of the three subjects acted as the recorder, all but removing them from the brainstorming experience (in the reviews of Diehl & Stroebe, 1987 and Lamm & Trommsdorf 1973, the groups that matched the performance of the nominal groups had two members). The present experiment used a production blocking manipulation, similar to what Street used in his 1974 study, but modifed it so that the performance of equal-sized brainstorming groups could be compared. This new manipulation resulted in a better test of the production blocking interpretation that people forget their ideas or are unable to generate additional ideas while remembering an idea they haven't expressed. The second hypothesis is as follows.

Hypothesis 2. Groups allowed to write their ideas on individual brainstorming forms will generate more ideas than those groups recording their ideas on a single group form.

This hypothesis was based on the idea that production blocking is responsible for the decrease in performance of groups working on a brainstorming task because they forget their idea while waiting to express it, they become distracted while listening to others expressing ideas, or they are unable

to develop additional ideas while holding an idea in their short-term memory (Diehl & Stroebe 1987). If writing materials are provided and they record their idea as it occurs, the chance of the subjects forgetting their idea or becoming distracted is reduced and their short-term memory is freed to develop additional ideas (Street 1974).

Evaluation and production blocking have been shown to have an effect on the behavior of brainstorming subjects, but there are also attitudinal elements of brainstorming, such as satisfaction, that should also be examined. Although satisfaction with brainstorming has been infrequently measured and reported in the brainstorming literature, it is possible to consider the relevant literature on job satisfaction, and apply those findings to the "job" of brainstorming.

Satisfaction. Job satisfaction became of interest to psychologists as a result of the Hawthorne studies of the 1920's. The results of the Hawthorne studies showed that workers had attitudes toward the work they performed and the measurement and understanding of those attitudes became the focus of industrial psychologists. Soon after research into job satisfaction began the idea that a happy worker is a productive worker was spawned. This notion led to the development of numerous experiments designed to determine the fact or fallacy of that idea. Brayfield and Crockett (1955) and Vroom (1964) evaluated the available research on

satisfaction and performance and concluded that there was only a slight positive correlation (.14) between satisfaction and performance (Vroom, 1964). Although the correlations were low, research continued into the satisfaction-performance area, but with a new idea that performance may lead to satisfaction.

In 1971, Hackman and Lawler proposed that performance leads to satisfaction through the fulfillment of higher level needs when the task is meaningful, contains identifiable functions, and if it includes some sort of feedback about the accomplished task. Baird (1976) classified tasks that include the above characteristics as stimulating and those tasks that do not contain the characteristics as nonstimulating. Baird theorized that jobs that are stimulating lead to satisfaction from good performance moreso than those jobs that are not stimulating, and tested this hypothesis in a field setting. The results of his study were opposite to his hypothesis and showed that performance was correlated with satisfaction only for nonstimulating jobs.

In applying Baird's classification to brainstorming tasks it appears that brainstorming would be a nonstimulating task because it has low levels of meaningfulness, identifiability, and feedback. Because of the nonstimulating nature of brainstorming, performance and satisfaction should be positively correlated, and the following hypothesis was proposed.

Hypothesis 3a. Satisfaction with the performance of the group will be positively correlated with the total number of responses for each brainstorming task.

Support for the above hypothesis is also provided from the brainstorming literature. Jablin (1981) conducted a brainstorming experiment and found that low apprehensive subjects were more satisfied with the performance of their group than the high apprehensive subjects, with the performance of the former being higher than the performance of the latter.

The global measure of satisfaction considered how satisfied the subjects were with the brainstorming task. Although global satisfaction has not been a frequent measure in brainstorming experiments, a few studies have found that subject satisfaction or enjoyment is diminished when brainstorming under high levels of evaluation (Collaros & Anderson, 1969; Maginn & Harris, 1980). The following satisfaction hypothesis was generated.

Hypothesis 3b. Subjects performing under low levels of evaluation will enjoy the brainstorming task more than those subjects performing under high levels of evaluation.

Previous research has found that subjects enjoy the interaction that comes from working in a group (Gallupe, Bastianutti, & Cooper, 1991; Gurman, 1968), and there is also a positive correlation between performance and satisfaction

with nonstimulating jobs (Baird, 1976). In the present experiment, groups performing under high levels of production blocking will have more group interaction during the brainstorming process than those subjects in the low level of production blocking, however, the performance of the latter group is expected to be higher, leading to satisfaction from good performance. Which group of subjects will be more satisfied with the brainstorming experience will depend on which aspect, performance or group interaction is more important to the subjects. Based on the findings of Gallupe, Bastinutti, and Cooper it is likely that group interaction will be more important to brainstorming groups than performance, when interaction is high (high production blocking). In their experiment the lower performing, but higher interacting groups, reported higher levels of satisfaction with the brainstorming experience than high performing low interacting groups. Although the results of Gallupe, Bastinutti, and Cooper indicate that there is a main effect for group interaction, the levels of interaction were quite different than those in the proposed experiment. In their experiment the subjects either interacted as a group or worked individually, however, in the present experiment subjects were interacting at low or high levels within a group. Because subjects will always be interacting to some degree, performance may become the more important factor for satisfaction with the brainstorming experience when

interaction is at a low level.

Hypothesis 3c. Subjects will be more satisfied with the brainstorming experience when they are working under high levels of production blocking, regardless of the level of evaluation. Subjects working under low levels of production blocking will be more satisfied with the brainstorming experience when evaluation is low compared to when it is high.

METHOD

Subjects

One hundred seventy-one subjects from the Psychology 120 subject pool participated in this experiment as part of a class requirement. Prior to running, subjects were blocked into same-gender, three person groups. The groups were counterbalanced for condition and experimenter.

Design

A 2 X 2 between-subjects factorial design was used to compare the brainstorming performance of groups. The two factors were evaluation (high and low) and production blocking (high and low).

Independent Variables

Evaluation. Evaluation apprehension occurs any time subjects feel their outputs may be evaluated or criticized. Evaluation apprehension may result from a fear of evaluation from sources inside or outside of the group. Evaluation from sources outside the group was the only form of evaluation intentionally manipulated in this experiment. The high level of evaluation was manipulated by informing the subjects that

their individual performance would be compared with the responses of other individuals. High evaluation subjects were also told that they would be observed and videotaped during the brainstorming session (see Appendix A).

The low level of evaluation was manipulated by informing the subjects only that their individual performance would be compared with the responses other individuals (see Appendix A).

Production Blocking. Production blocking has been described as the unspoken group norm that only one person talks at a time (Lamm & Trommsdorf, 1973). The result of production blocking is that other group members withhold their ideas or thoughts until no one else is talking, at which time they express their idea. The high level production blocking groups were given one brainstorming form on which to record their ideas. After they recorded their idea they expressed it to the group. A high level of production blocking occurred in this group situation because members were required to share the form and take turns recording their ideas. These procedures enforced the turn-taking that is characteristic of production blocking.

Diehl and Stroebe (1987) theorize that production blocking may occur as group members are waiting their turn to express their idea. As they wait they may become distracted by other group members, forget their idea, or dismiss the idea

in light of new information, leading to a reduction in number of ideas presented. Based on this theory by Diehl and Stroebe the low level production blocking manipulation was developed.

During brainstorming, low level production blocking subjects were allowed to record their ideas on individual brainstorming forms. After they recorded their idea they expressed that idea to the group. This procedure was intended to reduce the adverse effects that result when subjects are required to wait before expressing their ideas.

The low level production blocking manipulation was accomplished by providing all group members with writing materials on which to record their ideas. In this situation group members were not required to wait their turn and could record their idea as soon as it occurred. Immediately recording their ideas was thought to facilitate brainstorming by freeing up their short-term memory, and reduce the chance of subjects becoming distracted or forgetting their idea.

Dependent Variables

Several dependent measures have been employed in brainstorming research with the predominant measure being quantity of ideas or solutions. Quantity of ideas was determined for groups by adding up their total nonoverlapping ideas for each trial and using these scores for data analysis. Quality has also been used as a dependent measure, but researchers found a high positive correlation between quantity

and the global measure of quality (Diehl & Stroebe, 1987). For this reason other subdimensions of quality have been used such as probability of implementation, significance, originality, and creativity of the idea, and utility of implementation.

Attitudinal measures have also been examined by experimenters. Satisfaction with group performance was measured by Maginn and Harris, (1980) and Collaros and Anderson (1969). Data for satisfaction measures have usually been gathered from self-report questionnaire items which asked subjects how satisfied they were with their own and/or their group's performance. One performance measure (quantity) and two affective measures (satisfaction with individual and group performance and satisfaction with the brainstorming experience) were used in this experiment.

Performance Measures. Quantity was based on the total number of ideas that the group generated during each brainstorming trial.

Affective Measures. Satisfaction was assessed by asking subjects to indicate how satisfied they were with the brainstorming experience, and with their personal and their group's performance (see Appendix D).

Manipulation Checks

Evaluation Level. Perceived evaluation level was assessed by asking subjects to respond to several items on the questionnaire (see Appendix C).

Production Blocking. The success of the production blocking manipulation was assessed through several items on the questionnaire (see Appendix C).

Brainstorming topics

Two multiple uses and one consequences task were used for the experiment. For the practice trial subjects were asked to generate as many uses as possible for a coathanger. For trial one subjects were presented with the thumbs problem and for trial two subjects were asked to generate multiple uses for a brick (see Appendix B).

Procedure

Subjects were escorted into the lab and seated at the table. The experimenter then read the instructions for that condition as the subjects followed along on their own copies (see Appendix A).

After the instructions were read the experimenter asked if everyone understood the brainstorming instructions. The subjects were then given the first practice topic and told they had 5 minutes to brainstorm. They were reminded to

follow the rules of brainstorming throughout the entire experiment and were reminded of the brainstorming rules prior to each brainstorming trial. The experimenter then told the group to begin. The experimenter remained in the room during the practice trial to answer questions and to ensure that the subjects followed the experimental procedures.

Upon completion of the practice session subjects were allowed to ask questions about the brainstorming procedure. They were then given the first topic and told they had 12 minutes to complete the brainstorming trial. They were again reminded to follow the rules of brainstorming. The second trial was conducted the same as the first trial. The experimenter left the room during the trials only returning to tell the group their time was up and to give them their next topic.

After subjects completed the experimental session they were given the questionnaires. Upon completion of the questionnaires the subjects were debriefed, thanked, and dismissed.

Pilot Study

A pilot study was conducted to determine the success of the manipulations and to determine whether 12 minutes was enough time for completion of the brainstorming topics. Several different manipulations were tried for both factors with the most successful manipulations chosen for th

experiment.

The procedures for the pilot study were identical to those outlined above. Groups of three were used and they were presented with the brainstorming topics. After completion of the brainstorming trials the subjects were queried about how the experiment might be improved and/or changed. Subjects were then debriefed, thanked, and dismissed.

RESULTS

Before any hypotheses were tested, descriptive statistics were calculated and examined in order to determine if there were any major deviations from normality. Based on the analyses it was determined that no data transformations were required. Another procedure that was employed during data analyses was one suggested by Anderson and Ager, (1978) to ensure the use of the correct error term for nested designs. Since the design of this experiment had individuals nested within groups and groups nested within conditions, the use of an individual-level error term would be inappropriate for those measures that require averaging the individual responses to derive a group-level response. The specific procedure used during analysis of all group-level responses that were derived from individual-level responses was to nest the individuals within groups. The program used a nested and an unnested error term for separate analyses. If the results that used the unnested error term were not significant, then the nested error term and its results were used. For the sake of clarity, the nested error term was used for all subsequent analyses. For a more detailed description see Anderson and Ager.

Manipulation Checks

All manipulation checks were performed using the analysis of variance (ANOVA) design.

Evaluation Apprehension. Response to four of the six questions assessing evaluation apprehension were significant in the desired direction. When subjects were asked: "To what extent did you feel your individual performance was being evaluated during the experiment?" their differences were significant with $F(1, 56) = 23.95$, $p < .001$. The means for the high and low evaluation subjects were 4.46 and 3.43, respectively, on a seven-point scale. The question: "To what extent did you feel your group's performance was being evaluated during the experiment?" was also significant ($F(1, 56) = 9.81$, $p < .01$). The means for the high and low evaluation subjects were 5.18 and 4.25, respectively. When subjects were asked how stressed they felt by the conditions of the experiment their results were $F(1, 56) = 13.19$, $p < .001$, with means of 2.35 for high evaluation subjects and 1.63 for low evaluation subjects. The last evaluation manipulation check asked subjects; "To what extent they felt their ideas were evaluated by other members of the group?" This results showed no significant main or interaction effects, demonstrating that subjects felt more evaluated by sources outside rather than from members within the group.

Production Blocking. None of the production blocking manipulation checks showed a significant main effect for production blocking, but the response to two items were in the predicted direction. The failure of the manipulation checks may be due to the nature of their content which was based upon untested ideas for how or why production blocking occurs. If production blocking does not result in reduced performance because of the untested ideas then the questions will fail as manipulation check measures. Social desirability may have also been a factor with the responses the subjects reported, and will be addressed in the discussion section.

In defense of the production blocking manipulations are the findings that 93.1 percent of the subjects responded that they understood the brainstorming rules perfectly (1) or almost perfectly (2). When asked if they followed the rules of brainstorming 82.8 percent of the subjects stated that they followed the brainstorming rules always (1) or almost always (2). When asked to what extent they thought they should not talk while someone else was talking, subjects responded in the predicted direction, although the results were nonsignificant (M = 4.6 low production blocking, M = 5.05 high).

Group Performance

High evaluation was expected to result in fewer ideas being generated. The results of the ANOVAs failed to show a main effect for either of the two performance trials. For the

thumbs problems the results were $F(1, 56) = .00$, ns), with performance means of 33.76 (low) and 33.81 (high). For the brick problems the results were $F(1, 56) = .00$, ns, with performance means of 38.96 (low) and 38.88 (high). One can clearly see that the performance means were virtually identical across the low and high evaluation conditions (see Table 1).

Low production blocking groups were expected to generate more ideas than high production blocking groups. Results of the ANOVAs supported the hypothesis for both performance trials. The mean performance levels for the low and high production blocking groups on the thumbs problem was 39.2 and 28.5 ideas, respectively ($F(1, 56) = 11.38$, $p < .001$). Similarly, the mean performance for the low and high production blocking groups on the brick problem was 43.1 and 34.9 ideas, respectively ($F(1, 56) = 5.94$, $p < .01$) (see Table 1).

Satisfaction with Performance

High performing groups were expected to be more satisfied with their group performance than low performing groups. This hypothesis was tested by correlating questions assessing satisfaction with personal performance and satisfaction with group performance with actual group performance on each of the two trials. Results of the correlations failed to support this hypothesis for individual or group performance (see Table

Table 1

Mean performance of brainstorming groups

	Performance	
Manipulation	Thumbs	Brick
Low evaluation		
M	33.7	38.9
SD	12.5	14.3
High evaluation		
M	33.8	38.8
SD	13.0	11.1
Low production blocking		
M	39.2 **	43.1 *
SD	14.3	14.3
High production blocking		
M	28.5	34.9
SD	8.1	9.7

* $p < .01$ (between the low and high levels of production blocking)

** $p < .001$ (between the low and high levels of production blocking)

Table 2

Performance and satisfaction correlations

Satisfaction measure	Performance Measure: Thumbs	Brick
Individual Performance		
r	-.07	-.10
p	ns	ns
Group Performance		
r	+.13	+.19
p	ns	ns

2). In addition, scatterplots showed no signs of systematic nonlinearity.

A significant satisfaction finding was that high levels of production blocking were found to result in higher levels of satisfaction with personal performance ($F(1, 56) = 6.4$, $p < .01$). Explanations for this finding will be addressed in the discussion section.

Task Enjoyment

Low-level evaluation subjects were expected to enjoy the brainstorming task more than high-level evaluation subjects. A two-way ANOVA was performed using subject responses from a question which had subjects indicate to what extent they enjoyed the brainstorming task. Subjects responded favorably to the brainstorming task at approximately one point above the midpoint (M = 5.0 low and M = 5.1 high evaluation). The results of the ANOVA, however, failed to support the hypothesis (F (1, 56) = .19, ns).

Although no main effects existed in regard to task enjoyment, there was a significant crossover interaction ($F(1, 56) = 4.88$, $p < .05$). This interaction will be addressed in the discussion section.

Satisfaction With the Brainstorming Experience

High level production blocking subjects were expected to be more satisfied with the brainstorming experience,

regardless of the level of evaluation. Low production blocking subjects were expected to be more satisfied with the brainstorming experience when evaluation was low compared to when it was high. This hypothesis was tested with the following item: "Without considering the performance of you or your group, to what extent were you satisfied with the overall group experience?" Results of the ANOVA failed to support the hypothesis ($F(1, 56) = 2.29$, ns). It is interesting to note that the means for the response to this question were opposite to the hypothesized direction.

DISCUSSION

Evaluation Apprehension

One of the major findings of this study is that evaluation from sources outside the group has no adverse effect on the performance of brainstorming groups. In a similar experiment, Maginn and Harris (1980) found that evaluation from external sources had no adverse effect on individual performance. One of the major problems with their study, however, was that they did not measure how evaluated the subjects felt and therefore did not know if evaluation levels were different across the two evaluation conditions.

Using manipulations similar to those of Maginn and Harris (1980), Diehl and Stroebe (1987) found that evaluation from sources outside the group did adversely affect the performance of brainstorming individuals as well as groups. The present experiment used manipulations similar to those of Diehl and Stroebe, but found that evaluation levels did not significantly reduce the performance of brainstorming groups. In fact, the performance of the low and high evaluation groups was virtually identical across both evaluation levels.

The evaluation manipulation used in this experiment was intended to make the subjects experience different levels of apprehension during the brainstorming experiment. Measurement

of subject performance under each of the evaluation conditions was then examined to see if any performance differences existed that would be attributable to the evaluation apprehension the subjects felt. It is reasonably safe to conclude from the manipulation checks that there were differences in feelings of evaluation from sources outside the group. In comparison with low evaluation groups, high evaluation groups reported feeling higher levels of individual and group performance evaluation, and reported higher levels of stress due to the conditions of the experiment. On an individual level, all subjects reported feeling more evaluated from sources outside the group than from members within their group.

There are several possible explanations why the evaluation results of this experiment were inconsistent with the results of Diehl and Stroebe (1987). One potential explanation is that the subjects in the high evaluation condition did not experience enough evaluation apprehension. Although manipulation checks showed that the evaluation level experienced by the high and low evaluation groups differed significantly, evaluation may not have reached a high enough level in the high evaluation condition to result in performance differences between the two evaluation groups. The mean response for how evaluated the high evaluation subjects felt was 4.46 on a seven-point scale, but it may be that the minimum evaluation apprehension threshold would need

to be considerably higher. Diehl and Stroebe may have had higher levels of evaluation apprehension in their experiments because they required all subjects to wear clip-on microphones while brainstorming. The microphones may have led subjects to experience higher levels of evaluation which, in turn, may have led to the performance differences they found.

Another explanation for the divergent evaluation apprehension findings has to do with differences across the two samples. Diehl and Stroebe (1987) conducted their experiment using college students from a German university while this experiment used subjects from an American university located in the Midwest. Trying to determine if cultural differences existed that would moderate the evaluation/performance relationship would be difficult to determine at this time, but it does present a possible explanation that should be explored or accounted for in future experiments.

Another possible explanation is the nature of the topics used in the two experiments. Diehl and Stroebe (1987) used topics that had significant social relevance to the subjects. Socially relevant topics may have led the high evaluation subjects to experience more apprehension because they would have more fear about exposing undesirable or embarrassing aspects of themselves. The current experiment used topics that were fairly neutral leaving little room for embarrassment or exposing undesirable personal traits. Future replications

of the present experiment could test this alternative hypothesis by using topics having more social relevance to the subjects.

The most plausible explanation for the evaluation findings of this experiment is that subjects felt that the group (collective) not their individual (personal) inputs were the target of evaluation. Although the instructions specified that personal assessment of performance would be used, few subjects correctly responded to the question concerning the use of their ideas after the experiment. The majority of the subjects may have just assumed that the performance of their group was the target of evaluation. Additional support for this explanation is provided from the self-report measures. Subjects indicated feeling that their group's performance was evaluated at a higher level ($\underline{M}$ = 5.1 high evaluation, $\underline{M}$ = 4.2 low) than their individual performance ($\underline{M}$ = 4.4 high, $\underline{M}$ = 3.4 low).

If the subjects did feel that they were brainstorming under collective instructions then the results of the present experiment are consistent with those of Diehl and Stroebe (1987). They found that evaluation had no effect on brainstorming groups who were told their performance was being assessed collectively. The failure of the present experiment to establish conditions of personal assessment probably led to findings inconsistent with the hypothesis.

Production Blocking

Diehl and Stroebe, (1987) found production blocking to be the best supported reason for the difference in the performance of real and nominal groups. A problem with their results, however, is the lack of a group setting in which subjects brainstormed. The present experiment used a group setting and tested the effects of production blocking on group performance. The results of the present experiment overwhelmingly support the hypothesis that high levels of production blocking lead to reductions in group performance.

High production blocking was manipulated in the present experiment by requiring subjects to take turns writing their responses on a single brainstorming form and telling the group their idea. Low production blocking was manipulated by requiring subjects to write their ideas on individual brainstorming forms but take turns telling the group those ideas. This form of production blocking appeared to be the best method available for allowing only one individual to speak at a time. The group norm that only one member speak at a time has been identified as the major source of production blocking (Lamm & Trommsdorf, 1973). Subjects in this experiment experienced production blocking because they were not allowed to tell the group their idea until after they had written it down on the brainstorming form. This procedure prohibited more than one person from talking and enforced the brainstorming norm.

Production blocking manipulation checks were included not just to check the success of the manipulation, but also to help understand the mechanisms of production blocking. Interestingly, there were no significant differences between low and high production blocking groups on the manipulation check items. Specifically, there were no significant differences between subjects when they were asked:

(a) if they had enough time to brainstorm

(b) if they were hindered by taking turns

(c) if they experienced time pressure

(d) if they felt that they should not talk while someone else was talking, or

(e) how many ideas they forgot.

It must be pointed out, however, that the above manipulation checks may have been affected by social desirability or response sets possibly resulting in less than accurate self-report ratings. It is easy to understand that subjects would not want to respond truthfully to items that would reflect negatively on them or their performance.

Consider, for example, the question asking subjects to indicate how many ideas they forgot while brainstorming. How would subjects be able to accurately remember how many ideas they forgot if they forgot those ideas? If the subjects did remember how many ideas they forgot, would they want to accurately report information that would expose negative

information about themselves? Probably not, and for the reasons above it is difficult to rule out the notion of subjects forgetting ideas as a potential reason for the performance loss of high production blocking groups. Future replications of this experiment should include an alternative to self report measures to determine how many ideas subjects forget during brainstorming.

Another possible mechanism for how production blocking occurs was examined by using self-report responses. According to Lamm and Trommsdorf (1973) production blocking may occur because group members must share the available interaction time with other group members. Other researchers have refuted this notion by showing that ideas taper off towards the end of the session leaving ample time for expressing ideas. The self-report measures of this experiment indicate that all subjects felt they had ample time to complete the brainstorming task and felt no significant amount of time pressure during the experiment. This suggests that time sharing did not decrease performance in high production blocking groups.

Forgetting ideas provides a good explanation for the performance differences between the high and low production blocking groups. It is, however, difficult to imagine that high production blocking subjects would forget so many ideas and fail to remember or report them. With this in mind, it appears that production blocking may result from a variety of

factors, as Diehl and Stroebe (1987) proposed.

A final explanation should be discussed regarding how production blocking may work. As members are waiting for the brainstorming form to write their idea, they are required to hold their idea in their short term memory and their idea generation is temporarily halted until after they record their idea. Only after the idea is recorded can they resume brainstorming. The time lag between recording the idea and resuming brainstorming was greater for the high production blocking subjects and their effective brainstorming time was therefore less than the low production blocking subjects.

Satisfaction

None of the satisfaction hypotheses were supported by the results of this experiment. Satisfaction with the performance of the group was not correlated with the performance of the group. Low evaluation subjects did not enjoy the brainstorming task more than high evaluation subjects. No differences in satisfaction with the brainstorming experience were found.

Although the satisfaction findings were disappointing, there were two significant results regarding satisfaction that deserve mention. An interaction was found involving subject enjoyment of the brainstorming task. Low level evaluation subjects reported that they enjoyed the brainstorming task more when they were under high (M = 5.3) rather than low

($\underline{M}$ = 4.8) production blocking, while high evaluation subjects enjoyed the brainstorming task more when they brainstormed under low ($\underline{M}$ = 5.4) rather than high ($\underline{M}$ =4.9) production blocking. From these results, one can speculate that evaluation level moderates the salient features that subjects attend to during brainstorming. For example, when evaluation is low, subjects experiencing high production blocking are interacting more with the group and this interaction becomes the salient feature for task enjoyment. When evaluation is high, performance becomes the salient feature for task enjoyment. In this condition high performing groups (low production blocking) should report higher levels of task enjoyment.

The other finding of interest is that high production blocking subjects reported being more satisfied with their personal performance even though their group performance was lower. This finding may be tied to the subjects being able to more easily compare their personal brainstorming performance with other group member's performance on the common brainstorming form. Low production blocking subjects, on the other hand, used individual forms which made performance comparisons difficult to conduct discreetly.

Limitations and Directions for Future Research

The results of this experiment clearly support the idea that production blocking, moreso than evaluation, accounts for

process loss in brainstorming groups. There are several limitations to this study, however, that need to be addressed. First off, there is the issue of generalizability of the results. The experiment took place in a laboratory setting, used brainstorming topics that had minimal relevance to the subjects, and used a very homogenous. It is difficult to determine what effect each of the above factors had on the results without further research, but future experiments should focus on expanding these findings.

Another limitation is the nature of the groups used in the study. The groups used in this experiment are considered concocted groups, (McGrath, 1984) and many of the processes that occurred with those subjects would probably not occur with natural groups found in organizations. Natural groups would also have characteristics, not found in concocted groups, that may further limit the generalizability of the findings. Research conducted in field settings would easily determine the extent of this limitation.

A final limitation is the size of the groups used in this experiment. The majority of the brainstorming experiments have used groups of four or more. Very few researchers have used groups as little as three. It is quite possible that production blocking gets worse as group size increases, and that the effects of production blocking were more easily minimized by the small number of subjects used in this experiment. Research with larger groups should be conducted

to determine if production blocking can be minimized in larger groups as well.

The results of this experiment demonstrate that high and low levels of production blocking can be manipulated in group settings. Future research should focus on determining the mechanisms for how and why production blocking occurs, and seek ways to limit its occurrence. Future research should also work to expand the generalizability of these results to settings outside the lab, using topics of relevance to the brainstormers, and include several types of groups. Researchers wishing to conduct additional research on this topic in applied settings should be well received due to the favorable cost/benefit ratio of this type of experiment. The overriding goal of future research on this topic should be to work toward improving the functioning of all types of groups through a better understanding of the underlying processes of production blocking.

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APPENDICES

Appendix A

Low Evaluation, Low Production Blocking Instructions

Welcome to the brainstorming experiment. This experiment was designed to examine the communication process used by groups during brainstorming. During the next hour your group will be using the brainstorming technique to come up with as many ideas as possible to two problems. The brainstorming technique has four basic rules that must be followed. The rules are;

1) Generate as many ideas as possible.

2) Build on your own ideas as well as those of other group members.

3) The wilder the ideas you generate the better.

4) Criticism of your own or the ideas of others is strictly prohibited.

Are there any questions about the rules of brainstorming?

You will have one practice brainstorming trial to allow you to become familiar with brainstorming procedures, followed by two additional brainstorming trials. You will be given 5 minutes for the practice session and 12 minutes for each of the two subsequent trials.

The ideas that each of you generates today will be compared with the responses of individuals working alone.

When I signal you to begin brainstorming, as soon as an idea occurs to you write it on the brainstorming form and inform the group. After you have recorded your idea continue brainstorming.

Upon completion of this brainstorming experiment you will be asked to complete a short questionnaire concerning your reactions to this experiment.

Are there any questions about the brainstorming procedures?

Low Evaluation, High Production Blocking Instructions

Welcome to the brainstorming experiment. This experiment was designed to examine the communication process used by groups during brainstorming. During the next hour your group will be using the brainstorming technique to come up with as many ideas as possible to two problems. The brainstorming technique has four basic rules that must be followed. The rules are;

1) Generate as many ideas as possible.

2) Build on your own ideas as well as those of other group members.

3) The wilder the ideas you generate the better.

4) Criticism of your own or the ideas of others is strictly prohibited.

Are there any questions about the rules of brainstorming?

You will have one practice brainstorming trial to allow you to become familiar with brainstorming procedures, followed by two additional brainstorming trials. You will be given 5 minutes for the practice session and 12 minutes for each of the two additional trials.

The ideas that each of you generates today will be compared with the responses of individuals working alone.

When I signal you to begin brainstorming, as soon as an idea occurs to you write it on the brainstorming form and inform the group. If someone else is recording an idea on the brainstorming form you must wait until they have completed writing their idea and have passed the form to you before you tell the group your idea. It is absolutely necessary that you wait until you have the brainstorming form in your possession before sharing your idea with the group. Additionally, each person must record only those ideas that they generate and no one elses. After you have recorded your idea continue brainstorming.

Upon completion of this brainstorming experiment you will be asked to complete a short questionnaire concerning your reactions to this experiment.

Are there any questions about the brainstorming procedures?

High Evaluation, Low Production Blocking Instructions

Welcome to the brainstorming experiment. This experiment was designed to examine the communication process used by groups during brainstorming. During the next hour your group will be using the brainstorming technique to come up with as many ideas as possible to two problems. The brainstorming technique has four basic rules that must be followed. The rules are;

1) Generate as many ideas as possible.

2) Build on your own ideas as well as those of other group members.

3) The wilder the ideas you generate the better.

4) Criticism of your own or the ideas of others is strictly prohibited.

Are there any questions about the rules of brainstorming?

You will have one practice brainstorming trial to allow you to become familiar with brainstorming procedures, followed by two additional brainstorming trials. You will be given 5 minutes for the practice session and 12 minutes for each of the two subsequent trials.

The ideas that each of you generate today will be compared with the responses of an individual working alone. To facilitate this comparison, your brainstorming session will be videotaped and the tape used for evaluating your individual performance. In addition to the videotaping, there are people observing your group from behind the window and coding the dialogue during brainstorming.

When I signal you to begin brainstorming, as soon as an idea occurs to you write it on the brainstorming form and inform the group. After you have recorded your idea continue brainstorming.

Upon completion of this brainstorming experiment you will be asked to complete a short questionnaire concerning your reactions to this experiment.

Are there any questions about the brainstorming procedures?

High Evaluation, High Production Blocking Instructions

Welcome to the brainstorming experiment. This experiment was designed to examine the communication process used by groups during brainstorming. During the next hour your group will be using the brainstorming technique to come up with as many ideas as possible to two problems. The brainstorming technique has four basic rules that must be followed. The rules are;

1) Generate as many ideas as possible.

2) Build on your own ideas as well as those of other group members.

3) The wilder the ideas you generate the better.

4) Criticism of your own or the ideas of others is strictly prohibited.

Are there any questions about the rules of brainstorming?

You will have one practice brainstorming trial to allow you to become familiar with brainstorming procedures, followed by two additional brainstorming trials. You will be given 5 minutes for the practice session and 10 minutes for each of the two following trials.

The ideas that each of you generate today will be compared with the responses of an individual working alone. To facilitate this comparison, your brainstorming session will be videotaped and the tape used for evaluating your individual performance. In addition to the videotaping, there are people observing your group from behind the window and coding the dialogue during brainstorming.

When I signal you to begin brainstorming, as soon as an idea occurs to you write it on the brainstorming form and inform the group. If someone else is recording an idea on the brainstorming form you must wait until they have completed writing their idea and have passed the form to you before you tell the group your idea. It is absolutely necessary that you wait until you have the brainstorming form in your possession before sharing your idea with the group. Additionally, each person must record only those ideas that they generate and no one elses. After you have recorded your idea continue brainstorming.

Upon completion of this brainstorming experiment you will be asked to complete a short questionnaire concerning your reactions to this experiment.

Are there any questions about the brainstorming procedures?

Appendix B

Thumbs problem

Although this is unlikely to occur, suppose what would happen if everyone born after 1993 was born with an extra thumb on each hand. The extra thumbs would be built just like the present thumbs, but would be located on the other side of the hand. They would bend inward toward the fingers like the present one does.

For your brainstorming session, I would like you to determine what benefits and/or difficulties would arise when people start having these extra thumbs.

Brick problem

Generate as many uses as you can for a red clay brick.

Appendix C

Evaluation level

How many ideas did you withhold from the group?

_____ ideas

To what extent did you feel your individual performance was being evaluated during the experiment?

1 2 3 4 5 6 7

not at all very much

To what extent did you feel your ideas were being evaluated by other members of the group during the brainstorming session?

1 2 3 4 5 6 7

not at all very much

To what extent did you feel your group's performance was being evaluated during the experiment?

1 2 3 4 5 6 7

not at all very much

To what extent were you uncomfortable about the intended use of your own ideas after this experiment?

1 2 3 4 5 6 7

very uncomfortable very comfortable

To what extent did you feel stressed by the conditions of the experiment?

1 2 3 4 5 6 7

not stressed very stressed

Production Blocking

How many ideas did you forget while waiting for your turn to speak?

_____ ideas

To what extent did you have enough time to express all of your ideas?

1 2 3 4 5 6 7

had enough time — did not have enough

To what extent was your idea generation hindered by waiting for your turn to speak?

1 2 3 4 5 6 7

not at all — very much

How much time pressure did you feel while working on the brainstorming task?

1 2 3 4 5 6 7

none at all — very much

To what extent did you feel that you should not talk while someone else was talking?

1 2 3 4 5 6 7

not at all — very much

Appendix D

BRAINSTORMING RECORDING FORM

Please record all of your ideas on this form prior to presenting them to the group.

Appendix E

Please respond to the following questions by filling in the blank or by circling the number that best reflects your response.

1. To what extent did you understand the rules for brainstorming?

1	2	3	4	5	6	7
understood them perfectly						did not understand them at all

2. To what extent did you follow the rules of brainstorming during today's brainstorming session?

1	2	3	4	5	6	7
followed them always						did not follow them at all

3. What were you told would become of the ideas your group generated?

_____

4. Before today's experiment, how many times had you brainstormed in a group?

_____ times

5. How many ideas did you forget while waiting for your turn to speak?

_____ ideas

6. How many ideas did you withhold from the group?

_____ ideas

7. Were you acquainted with any of the other members of the group?

_____ yes

_____ no

8. To what extent would you like to work with these same group members again?

1 2 3 4 5 6 7

not at all very much

9. To what extent did you feel your individual performance was being evaluated during the experiment?

1 2 3 4 5 6 7

not at all very much

10. To what extent did you have enough time to express all of your ideas?

1 2 3 4 5 6 7

had enough time did not have enough time

11. To what extent did you feel it was important to focus your attention on the brainstorming task?

1 2 3 4 5 6 7

not important very important

12. To what extent did you feel it was important to focus your attention on social activities not related to the brainstorming task?

1 2 3 4 5 6 7

not important very important

13. To what extent was your idea generation hindered by waiting for your turn to speak?

1 2 3 4 5 6 7

not at all very much

14. To what extent did you feel your ideas were being evaluated by other members of the group during the brainstorming session?

1	2	3	4	5	6	7
not at all						very much

15. Without considering the performance of you or your group, to what extent were you satisfied with the overall group experience?

1	2	3	4	5	6	7
very dissatisfied						very satisfied

16. To what extent were you satisfied with your personal performance during this brainstorming experiment?

1	2	3	4	5	6	7
very dissatisfied						very satisfied

17. To what extent were you satisfied with the performance of your group during this brainstorming experiment?

1	2	3	4	5	6	7
very dissatisfied						very satisfied

18. To what extent were you interested in the brainstorming task?

1	2	3	4	5	6	7
not interested						very interested

19. Compared to other groups who participated in this experiment, estimate how well you think your group performed relative to the others?

1	2	3	4	5	6	7
much worse than average						much better than average

20. To what extent did you feel your group's performance was being evaluated during the experiment?

1	2	3	4	5	6	7
not at all						very much

21. To what extent were you uncomfortable about the intended use of your own ideas after this experiment?

1	2	3	4	5	6	7
very uncomfortable						very comfortable

22. To what extent did you enjoy the brainstorming task?

1	2	3	4	5	6	7
not at all						very much

23. How much time pressure did you feel while working on the brainstorming task?

1	2	3	4	5	6	7
none at all						very much

24. To what extent did you feel that you should not talk while someone else was talking?

1	2	3	4	5	6	7
not at all						very much

25. To what extent did you feel stressed by the conditions of the experiment?

1	2	3	4	5	6	7
not stressed						very stressed

When you have completed this questionnaire, please turn it over and sit quietly. I will return to debrief your group when all members of your group have completed the questionnaire.

Appendix F

Debriefing for

Understanding group processes during brainstorming

Today's experiment was designed to determine how brainstorming can be improved when used by groups. Previous research has shown that groups are routinely outperformed by individuals while working on a brainstorming task. The lower performance of groups is tied to several processes that occur while working in a group situation. For this experiment I was trying to isolate some of those processes to determine how and if they affect the performance of groups.

Your participation in this brainstorming experiment is appreciated by all the researchers involved. The information gained from your participation in this experiment will expand our knowledge of the group processes that occur during brainstorming and other group tasks. If you are interested in learning more about group processes, the following textbook references are included for your perusal.

Psychology 120 Textbook References:

Introduction to Psychology (1990 - 10th Edition). By Atkinson, Atkinson, Smith, and Bem. San Diego, CA: Harcourt Brace Jovanovich. (Spence). pp. 724-726

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Lamm, H., & Trommsdorff, G., (1973). Group versus individual performance on tasks requiring ideational proficiency (brainstorming). European Journal of Social Psychology, 3, 361-287.

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